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SANDIA NATIONAL LABORATORIES
CIVILIAN RADIOACTIVE WASTE MANAGEMENT OFFICE OF SCIENCE & TECHNOLGY and INTERNATIONAL PROGRAM

Test Plan 04-02

Experimental Work to Evaluate the Effects of Corrosion Of Waste Package and Wasteform Components on In-Package Chemistry and Radionuclide Mobility

Revision 0

Effective Date: August 5, 2004

Author:	*Original Signed by Patrick V. Brady* Patric V. Brady	Date:	07/29/2004
Author:	*Original Signed by Charles R. Bryan* Charles R. Bryan	Date:	08/05/2004
Review:	*Original Signed by James L. Krumhansl* Technical Reviewer, James L. Krumhansl	Date:	07/29/2004
Concurrence:	*Original Signed by Martha J. Mitchell* QA Reviewer	Date:	05/13/2004
Approval:	*Original Signed by Stephanie P. Kuzio* For Kathryn Knowles, SNL OSTI Project Lead	Date:	08/05/2004

REVISION HISTORY

Revision No.	Effective date	Description of Change
0	08/05/04	This is the original version of the test plan; no prior revisions exist.

Future changes to TP 04-02, other than those defined as editorial changes per the Office of Science and Technology and International Program (OSTI) procedure QAP 20-1, "Test Plans," shall be reviewed and approved by the same level of responsibility of persons that performed the original review and approval. All TP 04-02 revisions will follow the same distribution as the original document.

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Definition of Abbreviations and Acronyms

ASTM	American Society for Testing and Materials
ANL	Argonne National Laboratory
CCA	Compliance Certification Application
DAS	Data acquisition system
DOE	Department of Energy
EBSD	Electron backscatter diffraction
ICP-OES	Inductively-coupled plasma optical emission spectrometery
ICP-MS	Inductively-coupled plasma mass spectrometery
GC-MS	Gas chromatograph mass spectrometry
JCPDS-ICDD	Joint Committee on Powder Diffraction Standards – International Center for Diffraction Data
M&TE	Measuring and Test Equipment
NIST	National Institute of Standards and Technology
NAS	National Academy of Sciences
NBS	National Bureau of Standards
OCRWM	Office of Civilian Radioactive Waste Management
OSTI	Office of Science and Technology and International Science and Technology
PA	Performance assessment
PNNL	Pacific Northwest National Laboratories
RWP	Radiological Work Permit
SEM	Scanning electron microscope
SNL	Sandia National Laboratories
TP	Test Plan
WF	Wasteform
WP	Waste package
XRD	X-ray diffraction

Purpose and Scope

The project takes little credit for in-package uptake of radionuclides by corrosion products. This omission leads to substantially overestimated doses and physically unrealistic downstream models of radionuclide transport. This work allows better understanding of the overestimation as described in this experimental test plan.

The primary dose-critical isotopes at Yucca Mountain are predicted to be ^{99}Tc and ^{129}I over the first 50,000 years and ^{237}Np and ^{239}Pu afterwards (U. S. Department of Energy, 2001). The dose is over-predicted in the site recommendation because conditions in the surrounding corrosion product mass were conservatively assumed to be oxidizing and because:

- Reduction and sorption of ^{99}Tc onto metallic iron in corroding waste packages was neglected in the performance assessment, and
- Irreversible uptake of ^{237}Np and ^{239}Pu were neglected (in the license application, irreversible sorption of Pu will be considered, though with very large uncertainties).

These processes were ignored in the site recommendation because no technically defensible models existed at the time and their omission was thought to be conservative. This resulted in predictions of unrealistically high doses and unlikely transport scenarios. For example, dissolved Pu was predicted to move distances of several kilometers, when in fact only colloidal Pu is ever observed to move more than a few meters in field settings (Kersting et al., 1999). Np may behave similarly. Metallic iron is routinely used in the laboratory and field to remove dissolved technetium from solution (Bostick et al., 1990; Korte et al., 1997), yet the existing Yucca Mtn. model predicts rapid movement of dissolved technetium past enormous amounts of metallic iron (300 – 1200 grams per liter of void space) present in the degraded waste form, and ultimately into the environment.

The waste form (WF) is distinct from the corrosion-resistant waste package (WP) and consists of the large masses of metals and fuel elements inside the WP. When the WP is breached and the WF corrodes the latter will produce a heterogeneous mixture of radioisotopes, as well as substantial amounts of oxides of Fe and numerous other metals (Cu, Cr, Al, Zr, P, and Mo) that sorb or co-precipitate the radionuclides of interest. Under oxidizing conditions, Tc(VII) forms the stable pertechnetate ion, TcO_4^-. Pertechnetate compounds are highly soluble, and because pertechnetate is anionic and has a low charge density, it is neither strongly sorbed by common minerals nor readily sequestered through ion exchange. However, pertechnetate is strongly sorbed by Fe and ferrous iron compounds, and undergoes a surface reduction reaction to Tc(IV), which precipitates as low-solubility hydrous oxides and forms surface complexes on iron metal and aluminum oxides (e.g. Vandergraaf et al., 1984; Zhang et al., 2000). Such precipitates/coprecipitates may be sequestered by corrosion product overgrowth, or, even if re-oxidized to pertechnetate, may be re-reduced by the remaining metal surface (carbon and low-allow steels may only last for hundreds of years after waste package breach, but 316 stainless steel is expected to persist for hundreds of thousands of years). I sorbs to

Cu oxides (Balsley et al., 1996; Balsley et al., 1998). UO_2 fuel corrosion rates are lower under reducing conditions, limiting release of Np and Pu, which, in their reduced forms, are only sparingly soluble and are strongly sorbed by iron oxides.

Under oxidizing conditions, Np and Pu sorb strongly to Fe oxides – but rarely desorb (Liu et al., 2000). This is termed "irreversible sorption". Many of the metal oxides that will inevitably form in the degraded WF sorb radionuclides irreversibly and have been proposed earlier as backfill "getters" of radionuclides at low-level radioactive waste repositories, or are presently being used to clean up radioactive wastes (Krumhansl et al., 2002). In general, reversible sorption delays dose; irreversible sorption sequesters radionuclides permanently, lowering dose. However, irreversible sorption to colloidal particles may increase mobility—hence, the potential formation of colloidal particles must also be considered.

In order to develop a more accurate understanding of ^{99}Tc and ^{237}Np mobility, Sandia National Laboratories in partnership with Pacific Northwest National Laboratory (PNNL) and Argonne National Laboratory (ANL) will:

- Develop experimental evidence of the likely redox state inside the degrading WF - a parameter that controls corrosion product mineralogy, radionuclide solubilities, and sorption,
- Establish the nature and extent of reductive ^{99}Tc sorption that can be expected in the degraded WF and WP, and the permanence of Tc sequestration by corrosion product overgrowths,
- Measure and develop a model for irreversible uptake of Np,
- Investigate the formation and stability of colloid-sized particles, characterizing them with respect to size, quantity, and mineralogy.

The first and last task will be done at SNL. The second will be done at Pacific Northwest National Laboratory (PNNL) and the third at Argonne National Laboratory (ANL). Sandia will play an integrating role as the leader of the three lab effort. In particular, SNL will represent the project results to DOE-RW and take a lead role in developing overall models of source term behavior. Test plans for the PNNL and ANL work are being developed independently. Only the SNL tasks will be described immediately below. Except where explicitly noted, all work below will be done by SNL. This work will follow the general guidelines set forth in the May 17th, 2004 letter of guidance from OSTI.

General Scope of the Experimental Work

We will use scaled mockups of waste packages and waste forms to evaluate the probable range of redox states inside the WF, the mineralogy of likely corrosion products, the degree to which ^{99}Tc and ^{237}Np mobility is limited by reductive precipitation or irreversible sorption, and characteristics (quantity, mineralogy, and size) of colloidal materials that are released.

Previous Work

It is beyond the scope of this document to review the large body of literature on steel degradation, or the effects of redox on Tc and Np mobility. Instead, several reviews outline the surface chemistry and controls on Tc transport see (Bostick et al., 1990; Krupka et al., 1999a; Krupka et al., 1999b; Krupka and Serne, 2004 (in press)), Np (Combes et al., 1992; Kohler et al., 1999; Krupka and Serne, 2004 (in press); Susak et al., 1983), and experimental design of miniature waste packages (Zarrabi et al., 2003). These reviews establish the context for the experimental work and will be referred to, and considered further, in the output reports and technical articles produced by the present work. The linkages between corrosion, redox chemistry, and radionuclide mobilization will be described in detail in the final report of this project and in technical communications to be submitted for publication in peer-reviewed journals by SNL.

Experimental Process Description

Planning Overall Strategy and Process

SNL work in FY04 will focus on establishing corrosion pathways and in situ redox states in non-radionuclide bearing mockups. PNNL work in FY04 will target unraveling broad mechanisms of Tc uptake during corrosion. ANL FY04 work will target Np uptake by corrosion products. FY05 SNL work will involve radionuclide-included mockup analyses – to be discussed in a revision of the test plan. PNNL work in FY05 will establish the persistence of reduced/sorbed Tc in corrosion products. ANL FY05 work will consider sequential leaches of Np and spectroscopic analyses of the same. FY06 work at all three labs will involve combining experimental and theoretical analyses to develop an integrated source term model. Mockup construction will be done in the Dept. of Environmental Engineering at New Mexico Tech in summer/autumn 2004. A contract will be placed with New Mexico Tech for this purpose which will have as its object the construction and performance testing of three mockups. Performance testing will be done at New Mexico Tech and will involve establishing the performance characteristics of the mockups before handing off the mockups to SNL. SNL acceptance criteria for the mockups will include: construction (for example, closeness to desired dimensions, no leakage) and performance (results of long-term testing). Desired performance characteristics will require the measurement of influent and effluent analyses for redox sensitive parameters for several weeks. Ongoing technical support in the long-term testing of the mockups will be required from New Mexico Tech as well in FY04-FY06. The New Mexico Tech contract work will involve no work with radioactive materials.

Waste Package Components

The waste package to be used at Yucca Mountain is designed to withstand corrosion and failure, isolating the high level radioactive waste from the environment for extended periods of time. The waste form is distinct from the corrosion-resistant waste package (WP) and consists of the large masses of metals and fuel elements inside the WP and includes the inner shell of 316 stainless steel. When the WP is breached and the WF corrodes, a heterogeneous mixture of radioisotopes will be produced, as well as substantial amounts of oxides of Fe and other metals (Cu, Cr, Al, Zr, P, and Mo) that will sorb or coprecipitate the radionuclides of interest.

The major materials comprising the WP and WF are given in Table 1. Although the outer barrier may undergo localized corrosion and fail, it will not contribute significantly to mass of corrosion products that will form. Thus, it will not be considered further in this test plan. The inner barrier is 316 stainless steel. The WP consists of the spent fuel (UO_2) and the guides, stiffeners, tubes and plates supporting it. These are composed of primarily of carbon steel; some (Neutronit) contain boron as a neutron absorber for criticality control. Some are also aluminum. The total mass of each metal present is given in Table 1.

Table 1. Compositions of Major Components of the Waste Package and Waste Form (based on 21 PWR waste package; BSC, 2004, Section 4)

Component	Type of Material	Mass present, Kg	Chemical Composition
Outer Barrier	Alloy 22	$4.7 \cdot 10^3$	$Fe_{6.0}C_{0.015}Mn_{0.5}P_{0.02}S_{0.02}Si_{0.08}V_{0.35}Ni_{50.02}Co_{2.5}W_{3.5}Cr_{22.5}Mo_{14.5}$
Inner Barrier	316NG (stainless steel)	$1.05 \cdot 10^4$	$Fe_{62.075}C_{0.02}Mn_{2.0}P_{0.045}S_{0.03}Si_{0.75}Ni_{14.0}Cr_{18.0}Mo_{3.0}N_{0.08}$
Fuel Basket Plate	Al-6061	$3.4 \cdot 10^2$	$Al_{95.85}Fe_{0.7}Mn_{0.15}Mg_{1.2}Cu_{0.4}Si_{0.8}Ti_{0.15}Cr_{0.35}Zn_{0.25}$
Basket Stiffener, Basket Guides, and Fuel Basket Tubes	A-516 (carbon steel)	$5.9 \cdot 10^3$	$Fe_{97.87}C_{0.31}Mn_{1.3}P_{0.035}S_{0.035}Si_{0.45}$
CSNF	UO_2 fuel	$1.1 \cdot 10^4$	UO_2

We will build waste package mockups containing the major components of the waste form (e.g., carbon steel, aluminum, and stainless steel).

Mockup Experiments

Mockup Construction

The mockups will be machined at a scale of ~1:14 of the proposed waste packages at Yucca Mountain. Each mockup will be roughly 10 cm in (internal) diameter, with an internal length of 32 cm, and will be machined out of 316 stainless steel. An influent and effluent port will be built into the mockup as well as a solids sampling port. The waste package will contain coupons of carbon steel, aluminum, and stainless steel, such that the surface area of the components is reasonably close to proportional to the volume of the scaled down waste package. Polypropylene balls may be used as filler and distributed randomly throughout the internal volume of the package. Stainless steel is reasonably inert over the time scale of months. As needed a stainless steel-free control experiment will be done to show this.

The waste package mockup will have a inlet port of the top, and a sampling port at the bottom. The mockup will resemble a real waste package, but the bottom will be lightly sloped towards the outlet, such that water traveling through the waste form will, upon reaching the bottom of the mockup, be directed towards the sampling outlet. The sampling outlet will contain a steel in-line Millipore filtering setup with replaceable filters, so that suspended solids can be removed from the fluid samples collected prior to exposure to the atmosphere.

Other ports in the mockup will allow in-situ measurement of redox potential (although redox probes are relatively inaccurate, and this will also be determined from the concentration of redox sensitive elements in the effluent), and sampling of liquid from the center of the waste package.

Aqueous and Atmospheric Phase

The input fluid in the mockups will be air-saturated J-13 water.

Mockup experiments

Experimental work carried out at Sandia National Laboratories will consist of experiments with waste package mockups. 3 small waste package mockups, complete with interior components of stainless and carbon steel and aluminum (with the appropriate surface areas), will be machined and used for transport experiments. Each will have openings to ensure atmospheric access (but air will not be pumped into them), and will be placed in a glove box at fixed P_{CO2} and RH. They will have upper and lower ports for introduction and sampling of water and will be instrumented to permit in situ redox measurements. There will be two configurations: 1. Open to the air; 2. Closed to the air (The third mockup will be a backup possibly used to repeat experiments). These tests will be performed at Sandia. Standardized test protocols (e.g. sampling frequencies, inflow rates, air port dimensions) will be established in the course of the initial performance testing and will be documented in a subsequent revision of the test plan.

In all cases, input water concentrations will be monitored to evaluate mineral precipitation and/or sorption onto source containers and tubing. The effluent samples will be analyzed for iron concentrations by HR ICP-MS, spectrophotometry, and for colloids by dynamic light scattering. Analytical protocols for solids and liquids will be established in collaboration with New Mexico Tech collaborators and will be documented in a subsequent revision of the test plan. Synthetic J-13 water will be prepared at SNL and used as the input fluid.

Ports in the mockups will allow insertion and removal of steel and aluminum wires, so that corrosion progress and radionuclide uptake by corrosion phases can be monitored during the course of the experiment. Following termination of the experiment, the mockup will be disassembled, and the corrosion products and metal surfaces characterized by standard solids analytical techniques (e.g. XRD).

Analysis

Analytical work to be done at Sandia will rely on methods for the solids, including the colloids, may include zeta potential, X-ray diffraction, HR-TEM, electron microprobe, and SEM. Output fluid chemistries will be used to establish reasonable input chemistry ranges for the ANL surface complexation modeling effort. Again, the focus of the research is expected to evolve as data accumulates. This will likely necessitate development of new analytical protocols. The latter will be documented in subsequent revisions of the test plan. Chemistries of fluid inputs and outputs will be shared across SNL, PNNL, and ANL to maintain consistency in experimental boundary conditions.

Sample Control

Samples created routinely in the laboratory will be handled following the procedures described in OSTI QAP 13-1 "Control of Samples, Chemical Standards, and Chain-of-Custody." They will be labeled with a unique sample number, as described and recorded in the scientific notebook. Any necessary handling and storage requirements will be stated in the scientific notebooks. Failure to meet those requirements will result in the data being disqualified and the experiment repeated; this will be documented and the appropriate action taken, as described in QAP 13-1.

Should offsite sample transfer be necessary, it will be accomplished following the procedures outlined in this procedure. Other participants will have OSTI QA programs and procedure sets. They will also be on the OCRWM approved supplier list.

Data Control

A calibration program will be implemented for the work described in this test plan in accordance with OSTI QAP 12-1, "Measuring and Test Equipment." This M&TE calibration program will meet the requirements in QAP 12-1 for: (1) receiving and testing M&TE; (2) technical operating procedures for M&TE; (3) the traceability of our standards to nationally recognized standards such as those from the National Institute of Standards and Technology (NIST); (4) maintaining calibration records. In addition, QAP 13-1 identifies requirements and appropriate forms for documenting and tracking sample possession.

Data Quality Control

Data collection procedures are specific to individual instruments. Calibration of wet chemical instrumentation (e.g. pH meters) will be needed as appropriate. A full accounting of calibration needs will be made in a subsequent revision of the test plan as the specific analytical methods that are needed are identified. Any data acquired by a data acquisition system (DAS) will be attached directly to the scientific notebook or compiled in separate loose leaf binders with identifying labels to allow cross reference to the appropriate Scientific Notebook (Notebook Procedure QAP 20-2). If the instrument allows data to be recorded electronically, copies of the data disks will be submitted to the SNL Records Center. For instruments that do not have direct data printout, the instrument readings will be recorded directly into the scientific notebook.

Quality control of the Scientific Notebooks will be established by procedures described in OSTI QAP 20-2 "Scientific Notebooks and Routine Calculations." Methods for justification, evaluation, approval, and documentation of deviation from test standards and establishment of special prepared test procedures will be documented in the scientific notebooks. General procedures, goals and quality assurance controls for TP 04-02 are described below. Procedures including use of replicates, spikes, split samples, control charts, blanks and reagent controls will be determined during the development of experimental techniques as described in Section 5.1 above and documented in the scientific notebooks (as per QAP 17-1).

Data Acquisition Plan

The approach for collecting data varies for each instrument being used. Equipment data printouts will be attached directly to the scientific notebook or submitted to the SNL Records Center. For instruments that do not have direct data printout (balances, pH meters), the instrument reading will be directly recorded in the scientific notebook. The numerical data will be transferred from data printouts and scientific notebooks to Microsoft Excel spreadsheets. Data transfer and reduction shall be performed in such a way to ensure that data transfer is accurate, that no information is lost in the transfer, and that the input is completely recoverable. Data transfer and reduction shall be controlled to permit independent reproducibility by another qualified individual. A copy of each spreadsheet will be taped into the scientific notebook, and a second person will compare the data recorded in the notebook and that on the spreadsheet to verify that no transcription errors have occurred during technical and/or QA review of the notebook. This verification will be documented in the notebook when it is "signed off" by the reviewer.

Data Identification and Use

All calculations performed as part of the activities of TP 04-02 will be documented in a scientific notebook. The notebook will be technically reviewed periodically by a second person, who will note concurrence by co-signing the examined material. If a discrepancy is found, that discrepancy and its resolution will be documented in the notebook. In addition, there will be periodic quality assurance reviews of the notebook to ensure that the requirements of QAP 20-2 "Scientific Notebooks and Routine Calculations" are addressed.

Data generated under this TP will be used to evaluate the effects of corrosion of waste package components and high level radioactive waste, on in-package chemistry and the radionuclide source term at Yucca Mountain. This information will be used to develop a more robust model for radionuclide release from the waste package.

Equipment

A variety of measuring and analytical equipment will be used for the work described in this test plan. This equipment includes that listed below, as well as equipment not yet identified. A complete, up-to-date, equipment list, including serial numbers, will be maintained in the scientific notebook. Scientific notebooks will be used to record all laboratory work activity. Note that much of the analytical equipment that will be most heavily relied upon during the course of the work will be identified in the performance testing phase of the project since the characteristics of the experiment (e.g. effluent levels) will ultimately determine which methods are required. A subsequent revision of the test plan will document the methods, their ranges and so on. Other method and analytical equipment to be used for this project by SNL personnel include:

Weighing Equipment.

Several balances are present in the facility and may be used for this project. These include a Mettler AT-261 five-decimal place electronic balance, an ANC three-decimal place balance, and top loading balances and scales with maximum ranges of 2 to 150 kilograms. Balance calibration checks will be performed routinely using NIST-traceable weight sets, which are calibrated by the SNL Primary Standards Laboratory every 3 years. Balance accuracy and precision will be checked daily or prior to use (whichever is less frequent), using the calibration weight sets. Calibration checks will be recorded in a scientific notebook.

Liquid Measuring Equipment

Standard Laboratory Class A glassware (pipettes, volumetric flasks, etc.) will be used at all times. In addition, several adjustable Eppendorf pipettes are available for use in the laboratory. The calibration of pipettes will be checked routinely against a calibrated balance, and will be recorded in the scientific notebook.

Other Analytical Equipment

- Glass and digital thermometers – Solution and oven temperatures will be measured using either: 1) NIST-traceable liquid-in-glass or digital thermometers, calibrated on an annual or biannual schedule as determined by the calibration service provider; or 2) thermometers which have been calibration-checked against the NIST-traceable thermometers described above. Such calibration checks will be recorded in the scientific notebook.
- pH Meters and Autotitrators – solution pH may be measured using pH meters and/or autotitrators. The range for all pH meters is 0.00 to 14.00. Electrodes will be calibrated before each use or daily (whichever is less frequent) with pH 4, 7, and 10 buffers manufactured by Fisher Scientific with unique lot numbers and expiration dates; traceable to the National Institute of Standards and Technology (NIST). The accuracy of the buffers is ±0.01 pH units; buffer values will be adjusted for laboratory temperatures as per buffer instruction sheets if necessary. Calibration checks will be recorded in the scientific notebook.
- Equipment for Chemical Analysis – Several instruments may be used to chemically characterize the batch fluids and the effluent from the mockups. These include an Inductively-Coupled Plasma Mass Spectrometer (ICP-MS); a zeta-potential measuring instrument, and an ion chromatograph. These instruments will be user-calibrated according to the manufacturers specifications each time they are used and the calibration documented in the scientific notebook. The zeta potential meter will be calibrated against manufacturers-supplied standards (and others in the literature). Other instruments may be used as required.

Location and Personnel

All experimental work related to TP 04-02 will be performed at the SNL Albuquerque, the University of New Mexico, and New Mexico Institute of Mining and Technology. Sandia Personnel, including, but not limited to, Charles Bryan and Patrick Brady will carry out the work. Users of equipment indentified in this document have received appropriate training by virtue of advanced technical degrees and years of laboratory experience. Subcontract activities shall be done to the SNL OSTI QA program where appropriate.

Office of Science and Technology and International SNL QA Procedures (QAPs)

The following project documents cover the work described in this Test Plan.

QAP 1-1 – *Organization and Quality Assurance Program.*

QAP 2-1 – *Qualification and Training.*

QAP 4-1 – *Procurement.*

QAP 6-1 – *Document Review*.

QAP 6-2 – *Document Control.*

QAP 12-1 – *Measuring And Test Equipment.*

QAP 13-1 – *Control of Samples, Chemical Standards, and Chain-of-Custody*.

QAP 16-1 – *Corrective Action*.

QAP 17-1 – *Records Management.*

QAP 20-1 – *Test Plans*.

QAP 20-2 – *Scientific Notebooks and Routine Calculations*.

Any revisions in the above technical work documents that occur during the course of this project will be implemented, and do not require modification of this test plan. Current versions of the documents listed above are maintained at the following SNL OSTI web site: http://www.nwmp.sandia.gov/onlinedocuments/

In addition, procedures for use of the ICP, SEM, XRD, and UV-Vis spectrophotometer will be recorded in the scientific notebooks. If needed, a more detailed procedure will be written for these instruments. Procedures which may vary from sample to sample as work scope evolves, or one-time procedures, will be detailed in Scientific Notebooks, in accordance with QAP 20-2.

Records, Reports, and Audits

All records providing evidence of quality, including but not necessarily limited to personnel qualification and training forms, lists of M&TE and software, electronic data, technical procedures, laboratory notebooks, calibration records and certificates, and reports, will be QA records. These records will be maintained in accordance with QAP

17-1, “Records Management.” All records will be accurate, complete, identifiable, and legible, and will be inspected to ensure they satisfy these requirements prior to submittal to the SNL Records Center. Two copies of all QA records will be submitted.

Documents will be prepared for review and approval in accordance CRWMS procedure - with QAP 6-1, “Document Review.” QAP 6-1 requires that the author(s) and reviewer(s): (1) use the DRC Form QAP 6-1-1, (see Appendix A in QAP 6-1) in some, but not all, cases; (2) resolve all of the comments; (3) return this form with all signatures to the SNL Records Center. No procedures will be written as a result of this work. SNL personnel shall have access to contracted locations and activities for the purpose of evaluation of technical and quality assurance.

Training

All personnel involved in the experiments described in TP 04-02 will be trained and qualified for their assigned work. This requirement will be implemented through NP 2-1 “Qualification and Training.” Evidence of training to assigned procedures and any other required training will be documented through Form QAP 2-1-1 *Qualification and Training Form*. Annual Refresher QA training will ensure on-site personnel are trained to the OSTI QA Program.

Health and Safety

Work shall be done to the PHSs belonging to the laboratory facility where the work is done. The contract activities and ES&H training shall be done to the Health and Safety program of the organization doing the work. Documentation of the training shall be included in SNL OSTI training records This document describes the hazards associated with these experiments and the procedures to deal with those hazards, including all the training requirements for personnel involved in conducting the experiments. In addition, a Radiological Work Permit and Radiological Work License cover activities involving use of the X-Ray Diffractometer. Additional requirements may be mandated by SNL corporate ES&H, however their issuance will not require revision of this Test Plan.

Permitting/Licensing

RWL and RWP documents are in place for use of the X-ray diffractometer in Building 823. There are no other special licenses or permit requirements for the work described in this Test Plan.

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